Pondering Breakthrough Propulsion and Inertial Frame Physics

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Concepts for superseding the performance of rockets and solar sails, by using the discovery of new propulsion physics, have been in the scientific literature as early as 1963 [Forward]. A scholarly compilation of approaches was published in 2009 [Millis & Davis]. This presentation builds on that prior work, focusing now on a common challenge – how to address conservation of momentum while the physics of inertial frames is still incomplete.

Rockets satisfy conservation of momentum by expelling propellant in the direction opposite to the rocket's motion, and light sails by the change in momentum from the light hitting the sails. A subtle aspect is that this momentum conservation is defined relative to an inertial frame, and the properties of space that give rise to inertial frames are still not understood.

For breakthrough propulsion physics, where no propellant is used, the source of a reaction mass and conservation of momentum are often ambiguous. One approach is to seek some form of indigenous reaction mass in space, and then seek a means to interact with that mass to create thrust. Some calculations of the mass density of space arrive at astonishing numbers, for example 10^{18} kg/m^3 for the quantum vacuum, and 10^{25} kg/m^3 for the stress-energy of flat space ($c^4/8\pi G$). Another approach is to examine the fundamental physics of inertial frames. This second approach is the focus of this paper.

With the advent of Einstein's General Relativity in the 1920's, it was presumed that the unknowns of inertial frames would be solved [Barbour & Pfister]. This did not happen and the Riemannian formalism has been found to be unable to address momentum conservation for warp drives, wormhole transport, and Forward's gravitational dipole [Davis]. Furthermore, a number of new phenomena have been observed since then: (1) the Cosmic Microwave Background, with its reference frame properties and anomalous homogeneity, (2) anomalous rotation dynamics of galaxies that led to the "dark matter" hypothesis, and (3) quantum vacuum energy.

This investigation uses thought experiments to highlight the issues and then explore options for representing inertial frame properties of space. Next, alternative space-time formalisms that were used before Riemannian geometry are revisited, such as Eddington's optical analogy (where space has a variable index of refraction that is a function of a gravitational scalar potential). These perspectives are then combined to suggest a more detailed research path to understanding the connection between inertial frames and electromagnetism – with the intent to design experiments to see if such connections are detectable.

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